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# **NAVAL POSTGRADUATE SCHOOL**

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## **MBA PROFESSIONAL REPORT**

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**Analysis of Churn and Excess Material at the Pearl Harbor Naval Shipyard**

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**By: Lawrence Bangert,  
Kevin Cheshure, and  
Anthony Hunt  
December 2003**

**Advisors: Kevin Gue,  
Kenneth Doerr**

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**ANALYSIS OF CHURN AND EXCESS MATERIAL AT THE PEARL  
HARBOR NAVAL SHIPYARD**

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Submitted in partial fulfillment of the requirements for the degree of

**MASTER OF BUSINESS ADMINISTRATION**

from the

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# **ANALYSIS OF CHURN AND EXCESS MATERIAL AT THE PEARL HARBOR NAVAL SHIPYARD**

## **ABSTRACT**

For a Naval Shipyard, the amount of material ordered after beginning an availability (churn) and the amount of material ordered but not used (excess) are key performance indicators. Pearl Harbor Naval Shipyard's metrics indicate that an average of 50% of material ordered during an availability is ordered after the start of the availability and that 15% of material is excess. The NAVSEA goal for both metrics is 5%. We investigate the causes of high rates of material churn and excess at Pearl Harbor Naval Shipyard and provide recommendations for reducing them.



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## I. OVERVIEW

Pearl Harbor Naval Shipyard is a full service repair and maintenance facility, similar to many others throughout the Navy. Its mission is to provide rigorous phased maintenance and repair work at specified intervals, primarily on U.S. submarines. Shipyard work could be described as high tempo, well-orchestrated chaos. Large cranes shift heavy loads adjacent to the gauge calibration shop. Power cables from yet another shop run conspicuously through the middle of these two. Forklifts seem to be in constant motion along with the hydraulic lifts used to facilitate hull cleaning of the submarines in dry dock.

Maintenance intervals are normally determined by OPNAV (the office of the Chief of Naval Operations) and funding is passed incrementally throughout a fiscal year to offset the incurred costs of each ship or submarine. However, the shipyard has recently received a change order from OPNAV designating them as a “mission funded” command. This means that they receive an annual budget like other commands. It is now the command’s responsibility to manage its budget appropriately throughout the year and balance costs amongst all ship and submarine availabilities and the cost of running the shipyard.

The Material Department (Code 200) is the primary office within the command to execute logistics policy. Hundreds of civilian shipyard workers constitute the majority of the labor force, performing all of the actual repairs and associated labor (forklift and crane operation, etc). The amount of work done day to day is the result of a carefully planned out scheduling process that begins many months earlier. Other tasks pertinent to this study are performed throughout the organization including:

- Pre-planning of work to be done on each unit,
- Budgeting for each unit’s availability,
- Identifying material per individual work package,
- Ordering and tracking material,
- Receipt and storage of received material,
- Turnover of material to shipyard labor pool,
- Expediting material,
- Monitoring and reporting progress of repairs,
- Identifying churn and excess, and



- Managing excess material for future disposition.

The length of a repair stay depends on the type of availability for which a ship or submarine is scheduled. Ship Repair Availabilities (SRA) are characterized as high intensity, fast paced repairs of short duration, typically not more than 90 days. At the other end of the spectrum, units scheduled for the more comprehensive Engineering Repair Overhaul (ERO), could expect to be in the shipyard for 18 to 24 months. In order to maximize the amount of work done and to optimize the sequencing of work, engineering planners develop a work package anywhere from 11 to 18 months prior to the commencement of work, which is referred to as A-0 in industry parlance.

The volume of material requirements mandates that procurement commence well ahead of the scheduled work. Adherence to the schedule is a top priority. Delays in schedule have the potential to disrupt the overall process. Item “A” may be a key component in a critical path for items “B” and “C”. Any work stoppage in “A” may cause cascading delays down the line. In order to properly prepare for these critical requirements, certain parameters of material readiness are delineated. If followed, these parameters ensure timely availability of material for any one requirement. Parameters specify that material will be ordered well in advance. Items with longer lead times are procured earlier in addition to items that are more complex, require complicated contracts, and hard to find items. Many items may not be available or are out of production since the manufacturers are no longer in business. In these situations, the material department would have to search for a manufacturer capable of producing such an item and contract for production. However, the Navy Supply System fills most requisitions from existing inventories. Current shipyard policy for the procurement of material is listed in Figure 1.

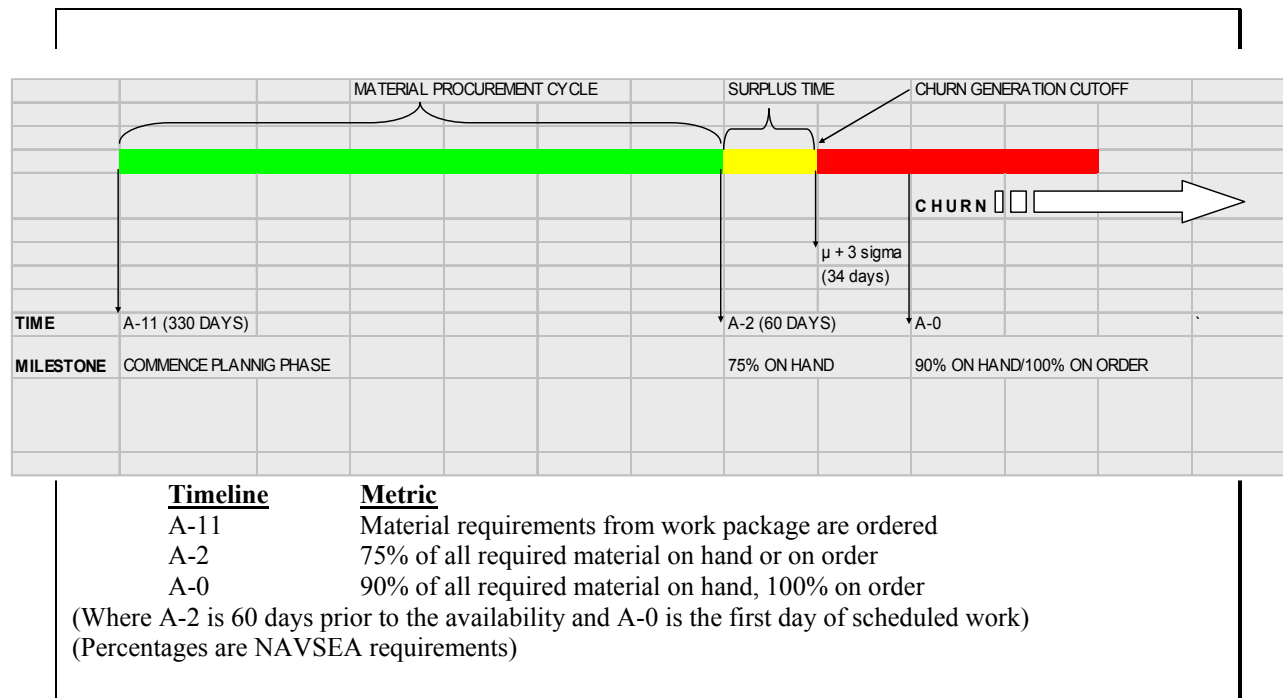


Figure 1: Material Requirement Timeline

Procurement of material in accordance with these metrics summarizes the core of the material department's responsibilities. Figure 1 depicts the basic timeline that is used for an availability and where churn generation begins (A-0). The material procurement cycle is where the bulk of the identified material requirements are ordered and filled. The first requirement that NAVSEA dictates occurs at A-2; here 75% of all required material for the availability is to be on hand (required material received by PHNSY personnel). Between A-2 and A-0 surplus time and churn cutoff fall. Expediting of material that is not expected to be received by the start of the availability needs to be done here. Expediting is where material procurement and receipt process are heightened. Delivery times need to be moved to ensure timely receipt of material. This is done by offering premiums to speed-up production and delivery times. Some contracts are even cancelled during expediting and new ones generated through different manufacturers to ensure timelines are met. At A-0 NAVSEA requires that 100% of all required material be on order and that 90% of required material be on hand.

## A. THE PROBLEM

Metrics provide a snapshot to evaluate performance. When a specific metric raises a flag, an in-depth examination and analysis by management might follow. The amount of input data and corresponding output relative to the scope of work in a shipyard is enormous. A wide span of oversight is maintained over various activities. Recent examinations have indicated that performance on material churn and excess do not meet NAVSEA standards. The two metrics of concern in this study are churn rates and excess material. Churn represents the percentage of material required that is identified and ordered after the start of an availability (A-0). Excess material consists of everything that was ordered for an availability, but not installed for some reason (unused material on hand 30 days after the close of an availability). NAVSEA's tolerance for both items is 5%<sup>1</sup>. PHNSY has recently reported rates in excess of 15% for both churn and excess. Based upon field interviews, the two most likely reasons are growth work and requisition maintenance. Growth work encompasses additions to previously identified repairs or maintenance that was not in the approved availability work package and additional parts required to complete jobs already scheduled. For example, a boat scheduled to have its refrigeration system overhauled discovers an additional broken valve that was not included for replacement as part of the overhaul. The subsequent material requirement would be considered "growth work." Requisition maintenance is the process whereby procurement clerks monitor the status of outstanding material. If a discrepancy exists, such as material not on hand by the supplier's published delivery date, then the clerks must expedite as necessary. Given the volume of material required, failure to closely monitor the flow of material can have significant effects. Supply clerks spend as much, if not more time performing requisition maintenance as they do actually submitting requisitions. High rates of churn and excess material could induce work delays and drain financial resources, respectively.

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<sup>1</sup> <http://www.navsea.navy.mil/specs&standards/>

## **B. OBJECTIVE**

The objective of this project is to conduct an operational analysis and assessment of the material requirement process. A recent policy requiring the use Local Management Indicator Codes (LMIC) on material ordered after A-0 has been instituted to assist in providing more detailed information on the causes of churn. The goal of this research is to identify and provide recommendations for the causes of churn and excess material generated above the specified threshold. We answer the following questions.

1. What are the causes of churn and excess?
2. What can be done to reduce or alleviate churn and excess?

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## **II. ANALYSIS**

### **A. INITIAL ASESMENT**

In determining the solution to the research question, several root causes were identified. These root causes were identified through numerous field interviews, and examination of historical records and various command directives. To test the validity of these root causes and answer the research question, statistical measures and field interviews were used along with evaluation of current practices against generally accepted principles of supply chain management and operations management. The field interviews and data collection yielded considerable insight into possible causes of churn and excess. However, due to time and manpower limitations, the study focused on what we considered the most significant contributors to the problems. These six contributors are requisition lead-time, requisition maintenance, forecasting techniques, configuration management (equipment validation), accountability, and incentives

### **B. LEAD TIME**

Examination of material lead times was conducted to determine if they could be contributing to churn and excess due to work stoppage or delay. Interviews with shipyard personnel suggested a perception that excessive supply system lead-time is the root cause of many problems. The analysis of lead times compared material lead times to their relative frequency. Since material orders are phased during the planning phase, if a significant portion of the lead-time distribution exceeds the time remaining in the planning phase, then the supply system could be inducing churn.

The analysis examined the population of requisitions for the month of June 2003. Specifically, all requisitions generated by the shipyard in the month of June for every submarine in both the planning and execution phases were included. The analysis included submarines in all types of availabilities at different stages of the repair process. Requisition lead-time data included values from 0 to 48 days. In the execution of the repair process, the shipyard uses material procured from outside sources as well as

material held locally (in stock at FISC or carried in its own shop stores). Lead-time does not include material from these local sources. It is for this reason that requisitions with customer wait times (lead time) of 3 days or less were excluded. Due to its remote location, items received in 2 days or less can be said with reasonable certainty to originate from within. Either scenario could properly represent items with resulting lead times of 3 days. However, there was almost no statistical difference in the resulting characteristics and values when eliminating lead times of 3 or less as compared to 2 days or less. It is for these reasons that the lead time review of June requisitions was limited to items having a lead time of 4 days or greater. Sample size totaled 2,561 documents. The following summary statistics apply (measured in days) and are summarized in figure 2:

Mean = 9.99

Standard Deviation = 7.85

99<sup>th</sup> percentile value = 33

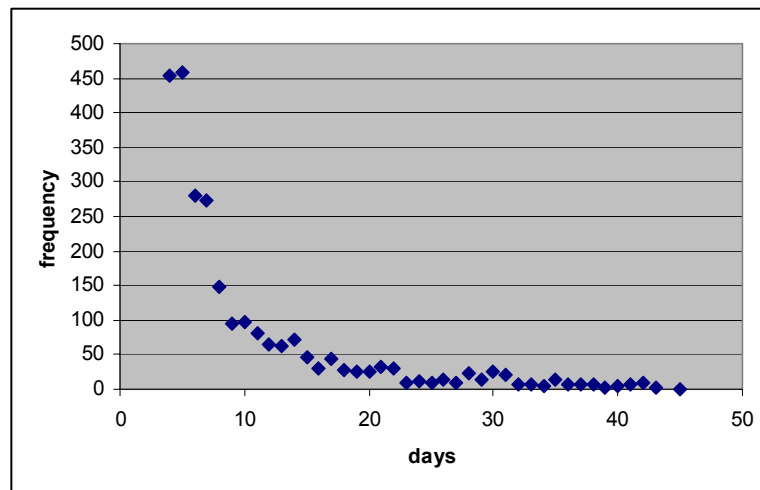


Figure 2: Distribution of Material Lead Time

Per the planning phase milestones for material procurement, this data suggests that excessive supply system lead-time is not a contributing factor. Toward the end of the planning phase, the last material metric prior to A-0 requires 75% of all material to be on hand or at least on order no later than A-2 (60 days out). As previously mentioned, the orders are staggered as best as possible to match their delivery sequence with the sequence of required work. Therefore, we conclude that at least 75% of the required

material will have a slack in lead-time of 26 days (60 day order point – 34 day lead time demonstrated above). This does not address the 25% of material not yet required to be on hand. However, the sequencing of material requirements precludes this from becoming a significant factor. Since the final metric requires 100% on order at A-0, the shipyard can plan to have 99% of all material required not later than A+34 days. The final 25% of material requirements will not be required in the first 34 days of repairs. However, it should be noted that failure to sequence requirements could adversely affect this trend. In the case of the 1% of requirements in excess of 34 days, lead-time required may not support the work schedule. The only other constraint in this scenario would be the limitation of the material-ordering branch to submit and generate requisitions in support of the prescribed timeline. They have indicated that no such limitation exists.

### **C. REQUISITION MAINTENANCE**

Despite the analysis and findings within the previous section, many material expeditors find themselves ensuring required delivery dates are met. In many instances, they are unable to have the required material on hand when needed. Requisitions are submitted as required; however required delivery dates (RDD) either cannot be met or are contingent on other requisitions with regards to quantity or associated equipment. This results in dual or triple path sourcing, where a second or sometimes third requisition is ordered without canceling the first requisition (hedging the bet on which will arrive first) or simply reordering after A-0. The hypothesis is that untimely requisition maintenance is the primary cause of many last minute expediting efforts. *Requisition maintenance is the process whereby material is monitored after it has been ordered to ensure it is flowing as requested.* Throughout the planning phase, procurement personnel are supposed to process the material outstanding file repeatedly to ensure that the most current status indicates that the estimated delivery date (EDD) is no later than the RDD. In the instance when an unacceptable EDD or outdated status appears, procurement personnel are supposed to either expedite the material or cancel it and pursue another source. Therefore, lead-time is also in large part a function of the efforts of material planners. In other cases, lead times are reasonable but still insufficient to meet a



prescribed due date. Reasons for excessive turn around time can include, but are not limited to, lack of current manufacturing, backorders and contract requirements.

We reviewed detailed requisition maintenance procedures at PHNSY, including the action taken to review the most recent status, the methods of identifying bad status, and the prescribed periodicity of these actions. In the review of shipyard instructions and various field interviews, PHNSY indicated that no policy exists for the continued review and update of outstanding requisitions. Therefore, the identification of bad status (i.e. unacceptable EDD) could occur too late within the planning phase window as efforts to expedite or outsource requirement are delayed. Untimely identification of this data could push the receipt of material past the date required.

#### **D. FORECASTING**

In the process of executing repairs and attempting to match material requirements with those repairs, forecasting is critical. The methods used to gauge equipment wear out and failures are directly related to the efficiency of the material procurement process relative to the overhaul. Furthermore, the degree to which forecasted amounts are monitored, reviewed, and updated will either maintain or inhibit the effectiveness of such techniques.

Required material is classified in one of two categories: mandatory or contingent. Mandatory items represent material that, due to the nature of the overhaul, has been deemed necessary to be removed and replaced. Inspection and evaluation of the item is not performed. The actual state of wear or failure of a particular item is not relevant. Analysis by NAVSEA will have determined if an item is classified as mandatory. The classification results from historical trends, or as are often the case, a redundant safety requirement in accordance with the Submarine Safety program. This latter case is well illustrated by a typical oil change on a car. In addition to removing and replacing all engine oil, the filter itself is replaced. In many instances, the filter may possess continued service life. However, the relative costs of a new filter as well as the consequences of an old filter failing make it efficient and cost effective to change the filter. Such is the case with mandatory material requirements. Mandatory items are identified in the planning

phase and ordered accordingly. Upon receipt and commencement of installation, *all mandatory material is installed*. Examination of forecasting techniques did not consider mandatory items.

Contingent material represents items that have not been deemed necessary for replacement in the repair/overhaul process. This designation also results from previous historical trends and/or the relatively minor cost or importance of an item. Contingent items are identified in the planning phase, but not always ordered. It is these items that constitute the analysis of forecasting techniques.

In analyzing the techniques developed for the forecasting of contingent material, SHAPEC (Ship Availability Planning and Engineering Center) indicated that it uses a heuristic approach for determining material requirements. Contingent items were ordered only when the engineers deemed them necessary, in essence a judgment call relying on the experience of an engineer. These procedures were not applied by an operations analysis team and did not use mathematical models that considered dependent variables such as historical failure, expected service life, ease of acquisition, cost, lead time, etc. The model is based upon a historical 50% metric. It states that if contingent material has been used in at least 50% of previous availabilities then it becomes a candidate for procurement. The material is then ordered in the planning phase if the planner feels it is necessary. Unlike mandatory material, this process requires the inspection of the old unit to determine whether or not replacement is required. Only if the part has failed or exhibits the appropriate wear and tear for prudent replacement, is the contingent material installed. Any instance in which material was not replaced would generate excess material. Consequently, failure to order contingent material that was subsequently required would generate churn. Therefore, the possible impact of inaccurate forecasting on both churn and excess material generation is significant. Excess material from one availability is set aside for use in a subsequent repair if needed. However, the shipyard has indicated that the process by which previously excess material is made available relies on physical searches for the material and rarely produces the material when required.

The process by which SHAPEC determines if an item meets this threshold again differs greatly from other conventional models. A brief description of their current methods along with relevant dilemmas is presented.

1. Historical reviews based on sample size of 1. In determining whether the 50% metric has been met, SHAPEC reviews the demand from the last overhaul.<sup>2</sup> In some instances, the previous two boats are examined. This represents only a small sample size and could not represent the true metric in determining whether to order or not to order using the 50% metric. The SHAPEC representative reported and noted that the available data is limited (less than 100 overhauls). Many of which do not have reliable computerized data for analysis.
2. Use of heuristics in forecasting process. In further discussions with the SHAPEC engineering team, our team also noted the use of expert opinion as the basis for procurement of material in the planning phase. Furthermore, there are no command published guidelines regarding the use of heuristics. The potential for different estimates among different personnel is large.
3. Supplemental directive that hinders the process. In an effort to combat recent levels of excess, a recent standing order has been announced stating that all contingent material that has been ordered will be installed.<sup>3</sup> Per PHNSY, the rationale for this was twofold: First, it would alleviate material left over at the end of the availability. Secondly, this would better maintain the affected system in the long run. Since the component has been broken down, replacement of an old part should further improve system reliability. While the intentions appear sound, the effects on churn and excess are equally tangible. If contingent material is installed at every opportunity, this will

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<sup>2</sup> Obtained during SHAPEC representative interview.

<sup>3</sup> Obtained during interview with the Chief Engineer PHNSY.

cause the historical use to incorrectly approach 100%. Material will be installed, regardless of the current state, which will cause a re-order in the subsequent cycle, and so on. This will further preclude the process from identifying which contingent material is actually required to combat failure. Escalated material costs and inaccurate demand history could follow.

We believe there are four scenarios for material procurement. Each scenario is based upon two criteria: whether the material was needed and whether the material was ordered. Two of the four scenarios provide optimal results for the shipyard. These are represented by material that is purchased and required as well as material not purchased that is not required. Material that is purchased but not required generates excess, and required material that is not purchased but later needed and ordered will generate churn.

The cost of each scenario differs significantly and greatly affects the ultimate course of action. A brief cost analysis is presented here for each scenario. If required material is purchased, the resulting cost is limited to the purchase price. For the purpose of this analysis, \$100 will be used to illustrate purchase price. Consequently, if material is purchased and not required, the total cost would be \$100 + inventory holding cost. If material that is not required is not ordered, the cost is zero. The highest costs are realized when required material is not ordered. In this instance, the total cost would be \$100 + the cost of expediting + the cost of work delays. The latter two costs can be difficult to estimate; however, the shipyard has indicated that such costs are extremely high. Since churn has the highest potential opportunity cost, avoidance of this last scenario is critical in the forecasting process.

Having analyzed the various scenarios, the final step in the forecasting process is the development of guidelines for decisions. There is no one formula or process that is absolute in determining whether or not to procure an item. However, three criteria are most significant.

1. Cost of the item, which determines the potential cost of an excess.
2. Probability that the item is required (based on historical demand).

3. Criticality of the item (determined by two criteria: (1) whether the item is in the critical path of a repair and (2) whether the item keeps a vessel from getting underway).

An exact decision rule is beyond the scope of our study, but a small example should illustrate the intuition: A low cost item involved in a repair on the critical path for the availability is a good candidate for ordering, especially if it is low cost. A high cost item, not in a critical path repair, should only be ordered if there is a high probability it will be needed. The challenge is to define appropriate values for “high” and “low”.

## **E. CONFIGURATION MANAGEMENT**

Configuration management is critical to the supply chain management of any equipment in the military. Maintaining an aggressive configuration management program will help to ensure supply personnel stock the correct parts in a budgetary system filled with financial constraints. Inaccurate or untimely configuration management causes incorrect material to be ordered (“received the right part for the wrong system”). Subsequently, the correct item must be ordered after A-0 to ensure that a churn item does not contribute to excess.

Configuration changes are usually ordered by NAVSEA and implemented via the TYCOM (Type Commander). Since configuration changes require funds for implementation, they are usually done by the ship when funds are made available to the ship. A configuration change or alteration may be done as a Ship Alteration (SHIPALT) or some other type of alteration such as an Ordnance Alteration (ORDALT). Any alteration may have a direct effect on equipment data or parts data that will require changes to the ship’s COSAL (Consolidated Shipboard Allowance List). It is incumbent upon the ship’s Supply Officer to ensure all paperwork is filed in support of any configuration change done aboard the ship.

Possible results of failure to properly document configuration changes are significant. Funding shortfalls create a myriad of problems throughout the military. Two 688 class submarines may look the same from the outside and may even be numbered consecutively (SSN 760 & SSN 761) but may be very different on the inside. If both

boats are in the same squadron, there may be sufficient funds available to install new equipment (configuration changes) on one boat. If the ship fails to submit the proper forms (i.e. 4790 CK), then NAVSEA may not know the new equipment (or update) has been installed. Since SHAPEC acquires its ships data from NAVSEA, a failed configuration change notification may result in SHAPEC listing the wrong requirements on a TGI (Task Group Instruction)<sup>4</sup> for an upcoming availability. Figure 3 depicts the normal process of a configuration change. The critical path in figure 3 is the path connecting the 4790CK from the ship to NAVSEA

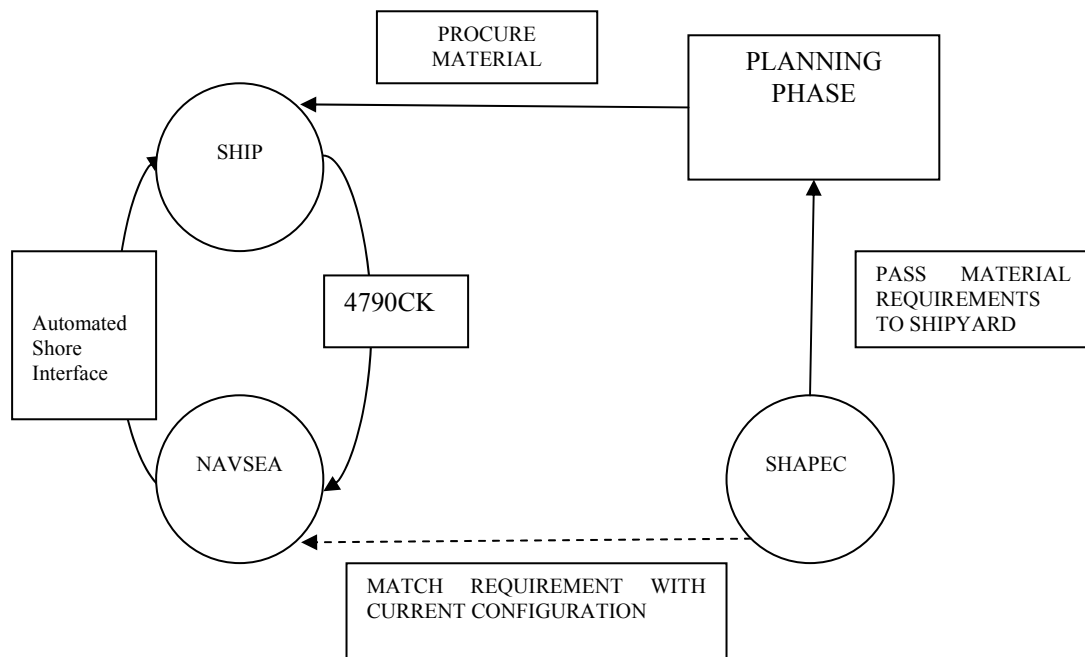


Figure 3: Normal Configuration Management Process

In an interview conducted with COMSUBPAC (CSP) staff (October 9, 2003), we determined that configuration management is being done aggressively and that turnaround time (the time it takes for a 4790CK submitted until the results show up on an

<sup>4</sup> 688 SHAPEC Non-Nuclear Non-Test TGI (Task Group Instruction Development Guidelines), dated 24 April 2003

ASI and are input into the ship's COSAL) averages approximately two weeks. Additionally, follow-up procedures and CSP interaction support a COSAL accuracy level of greater than 98%.<sup>5</sup> Therefore, all results suggest that configuration management in the Submarine Force (Pacific) is not a major contributor to churn at the Pearl Harbor Naval Shipyard.

## **F. ACCOUNTABILITY**

The absence of material control procedures (post issue custody and stowage) dramatically increases the potential for material misplacement and loss. This induces both churn and excess (churn for reorders when material cannot be found and excess in the case where material that was reordered is subsequently located). The following assumptions were made in order to sufficiently analyze the data provided by PHNSY.<sup>6</sup> The data used for this analysis was collected from the USS Santa Fe and the USS Tucson. Both boats underwent a Depot Scheduled Restricted Availability (DSRA). In the following text the word document represents a requisition and/or part. The total number of documents for Tucson is 6,133 and for Santa Fe is 7,548 (see Table 1). It should also be noted that it is not mandatory to submit LMI (Local Management Information) codes for churn requisitions until January 1, 2004. The documents for the selected boats contain sufficient quantity of LMI codes to allow for analysis. For the purpose of this study, only those documents with LMI codes attached were reviewed. See appendix A for complete LMI code breakdown and definitions.

Churn is the by far the most difficult goal to control at PHNSY.<sup>7</sup> Most would envision a Just-in-time supply system where the part is there exactly when the customer requires it for use. Since availability schedules are controlled by NAVSEA, the shipyard must concern itself with meeting NAVSEA timelines for an availability period. Under the new mission funded budget program, the shipyard must also concern itself with

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<sup>5</sup> interview with COMSUBPAC (CSP) staff ( October 9, 2003),

<sup>6</sup> information obtained through data collection from Mr. Alan Fujita

<sup>7</sup>obtained from interview with PHNSY Commanding Officer and Material Department Supervisor.

managing both time and money under even greater constraints. Churn is a variable that negatively affects the budgetary planning system – specifically forecasting. Churn uses funds not planned for during the planning phase of the pending availability.

The number of documents submitted during the DSRA for Tucson and Santa Fe totaled 13,681. Of this total, 7,395 (54%) were submitted as churn (after the official start date of the DSRA): 44.55% were churn without LMI codes, compared to 9.5% with LMI codes. Table 1 provides a complete breakdown of individual LMI codes for both boats. The data presented was extrapolated from only partial LMI codes. However, the data still provides good insight to the analytical capabilities of LMI codes with respect to reducing churn.

Approximately 1.6% of all churn generated (both boats) was due to lost material or mistake on TGI/ordered wrong material. This number could be much higher if LMI codes were submitted with each churn document. If we extrapolate based on the limited LMI data presented, we can estimate that LMI codes “L” and “M” could have accounted for up to 702 items as *lost* or *wrong material ordered*. There is no system in place to provide financial information to the Planning Officer or Material Officer concerning the dollar amount lost.

LMI codes “G” and “M” seemed to present problems for future analysis. Specifically for code “G”, there is no clear way to differentiate between growth work and rework. Because the two causes are very different, we recommend that the LMI codes be further broken down to provide more accurate information. While growth work may be an acceptable reason for increased churn, rework should probably be treated as a *red flag* and scrutinized by the appropriate manager or supervisor. LMI code “M” does not specify whether the problem is due to a mistake on a TGI or if the wrong material was ordered. LMI code R provides no value for future analysis. As referenced in the section on requisition maintenance, an unacceptable RDD can be identified prior to the A-0 date. Items ordered after A-0 date should be researched by the ordering activity to ensure requested RDD could be met. LMI code D requires further breaks down to indicate if the material was damaged in shipment or during the movement of material after receipt by the end user.



		<b>Defense Scheduled Restricted Availability(DSRA)</b>		<b>Total</b>
		<b>Tucson</b>	<b>Santa Fe</b>	<b>Docs</b>
Total Documents Submitted		6,133	7,548	13,681
Churn Start Date (A-0) start of the availability		19-Feb-03	09-Apr-03	7,395
Total Churn Documents Submitted		3,143	4,252	
Percentage of Documents Submitted as Churn		51.25%	56.33%	
<b>LMI Code</b>	<b>LMI Code Defined</b>			
9	Invalid Code	1	0	1
7	Invalid Code	2	0	2
A	Additional material required	677	42	719
D	Damaged/unusable material	3	2	5
E	Empty consumable bin	5	0	5
G	Growth work/rework	33	138	171
L	Lost material	21	13	34
M	Mistake on TGI, ordered wrong material	24	62	86
N	New work	205	42	247
Q	QA rejected	1	1	2
R	RDD unacceptable	3	0	3
T	Originally omitted from TGI	6	2	8
W	Wrong material received	7	5	12
X	Expired shelf life	5	0	5
<b>Total Churn Documents Submitted with LMI Codes</b>		993	307	1300

Table 1: Sample of Santa Fe and Tucson LMIC Churn Data

## G. INCENTIVES

No quantitative analysis of incentives and their relation to the research question was performed. It is mentioned here only as an observation. Employees ranged from a few military members, to contractors, to GS (Government Service) employees. Job descriptions are precise; however, a criterion governing the measurement of job requirements was not. Multiple field interviews indicated that the organization did not possess distinct incentives relative to job performance. As an example, in the instance where material has been lost or misplaced, items may be re-ordered without further investigative action. Such re-orders could generate churn or excess material. Although no formal analysis was conducted to quantify the extent to which an incentive program could mitigate churn and excess, if any, we suspect that a correlation might exist.

### **III. CONCLUSIONS**

As a result of the analysis, the following conclusions regarding the causes of churn and excess material are delineated:

- a. Supply system lead-time is not a contributing factor in the generation of churn and excess material.
- b. Consistent maintenance of outstanding requisitions can allow for timelier expediting and alternate requisition options. This would increase the lead-time available to process material requirements.
- c. The absence of quantitative forecasting models is diminishing the effectiveness of material forecasts.
- d. Configuration management is not a contributing factor in the generation of churn and excess material.
- e. Lack of material control procedures are directly related to increased levels of churn and excess material. Furthermore, the limited scope and use of LMI codes is not providing adequate information to combat churn and excess.
- f. Establishment of an incentive program could reasonably be expected to encourage stricter material scrutiny, thus reducing churn and excess.

There are limitations to the application of these conclusions. There are two ideologies observed within the shipyard's management of material: maximum readiness and minimal inventory. Both practices have received significant academic endorsement. No position is taken here regarding which practice is more prudent. What is significant is that both positions are mutually exclusive, hence the following caveat: there is a point at which either churn or excess can only be reduced at the cost of increasing the other. It was also noted by PHNSY that the single most important requirement during an availability is adherence to the schedule and that every other goal, without exception, is subordinate to attainment of the scheduled completion date. Our team took no exception

to this priority. However, we note only that certain levels of churn and excess material above the prescribed threshold appear to represent the cost of doing business.

#### IV. RECOMMENDATIONS

The following recommended courses of action are prescribed regarding the conclusions in chapter III:

- a) Lead Time Avoid dual sourcing of requisitions regardless of the circumstances. Ensure identification and ordering of all known requirements approximately one month (34 days) prior to the commencement of work. Consistent maintenance of outstanding requisitions can allow for more timely expediting and alternate requisition options and increase the lead-time available for processing material requirements.
- b) Requisition Maintenance (1) Cancel the requirement and seek an alternate source *if and only if* it can meet the required delivery date. This must be done in a timely manner. Dual sourcing to “hedge” requirements is not recommended and will potentially yield churn and or excess material. (2) If the stock system is the sole source of the requirement, expedite to the degree possible, but take no further action. Although not desirable since the required delivery date may not be met, there is no other recourse. Either way, neither churn nor excess material will be generated.
- c) Forecasting Develop and implement a formal methodology for determining what items to order for an availability. Such a methodology account for the cost of the item, the likelihood it will be needed in the repair, and the importance of the repair to the availability.
- d) Configuration Management Monitor LMI codes to ensure significant amounts of churn and/or excess are not generated due to configuration discrepancies. If such discrepancies occur, immediately reconcile class discrepancies with Type Commander and NAVSEA.
- e) Accountability Develop and enforce material control policies. This should include procedures for transfer and custody of material until final disposition as

well as investigative requirements for losses above a prescribed threshold or when irregular circumstances are present.

- f) Incentives Establish an incentive program, to include both positive and negative controls, to optimize material management. Job descriptions are precise; however, a criterion governing the measurement of job requirements was not. Field interviews indicated that the organization did not possess distinct incentives relative to job performance. As an example, in the instance where material has been lost or misplaced, items may be re-ordered without further investigative action. Incentives for employees to be held accountable for what happens to the issued material can help reduce lost or misplaced items. Recognition for reducing these type items can ensure the employees are performing and becoming part of the solution. Recognition is the positive side of incentives, but negative incentives have to be in place as well. Holding the employees accountable for those lost and misplaced items, by adverse performance reports, lost of time off and the cost associated with those parts are just a few examples.

## APPENDIX A - LOCAL MANAGEMENT INFORMATION CODES (LMIC)

Effective January 2004, use of LMI codes are mandatory after A-0 on requisitions Job Material Listing (JML) or Material Ordering Requests (MOR). Source: Enclosure 1 of TB02-22.<sup>8</sup>

Authorized Codes Defined.

Code	Description
G	Growth work, or open and inspect work, rework
N	New work
A	Additional Appendix M material required for the job. Amount is insufficient as ordered for the job by the original TGI.
T	Originally omitted from TGI – should have been ordered
M	Mistake on the TGI – ordered wrong material
R	RDD – Delivery date unacceptable
S	Substitution of TGI material for convenience
D	Damaged material; unusable – whether damaged in transit, damaged by Shipyard/FISC or damaged by mechanic
E	Empty consumable bin/van item
L	Lost material
Q	QA inspection rejects
W	Wrong material received from supply
X	Expired shelf life

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<sup>8</sup> 688 SHAPEC Non-Nuclear Non-Test TGI (Task Group Instruction Development Guidelines), dated 24 April 2003

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## APPENDIX B - LIST OF ABBREVIATIONS, ACRONYMS, SYMBOLS

ASI	Automated Shore Interface
COSAL	Coordinated Shipboard Allowance List
COMSUBPAC (CSP)	Commander Submarine Pacific
DSRA	Depot Scheduled Restricted Availability
EDD	Estimated Date of Delivery
ERO	Engineering Repair Overhaul
FISC	Fleet and Industrial Supply Center
FY	Fiscal Year
GS	Government Service
IMF	Intermediate Maintenance Facility
JML	Job Material List
LMIC	Local Management Information Codes
MOR	Material Ordering Request
NAVSEA	Naval Sea Systems Command
OPNAV	Office of the Chief of Naval Operations
ORDALT	Ordnance Alteration
PHNSY	Pearl Harbor Naval Shipyard
QA	Quality Assurance
RDD	Required Delivery Date
SHAPEC	Ship Availability Planning and Engineering Center
SHIPALT	Ships Alteration
SRA	Selected Restricted Availability
TGI	Task Group Instruction
TYCOM	Type Commander



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